DOI:
10.1093/rheumatology/kez222

Document Version
Peer reviewed version

A longitudinal birth cohort study of early life conditions, psychosocial factors, and emerging adolescent sexual orientation

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Acknowledgements: The authors are extremely grateful to all the families who took part in the Millennium Cohort Study. We are also grateful to the Centre for Longitudinal Studies, Institute of Education for the use of the data and to the UK Data Archive and Economic and Social Data Service for making them available. YX is supported by a King's-China Scholarship.

Funding: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest: The authors declared that they had no conflicts of interest.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Data availability statement: The data that support the findings of this study are available from the UK Data Service with a standard End User licence.

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Abstract

This study tested whether previously reported associations between early life factors and later adolescent sexual orientation could be replicated in another prospective birth cohort, the UK Millennium Cohort Study (MCS). We used data on 9795 youth from the MCS. Emerging sexual orientation was assessed using measures of sexual attraction to males and females in separate items at 14 years. Factors including birthweight, breastfeeding, sibling composition, parental ages, maternal psychopathology, parent-child relationship, and contextual risks were separated into three developmental periods: prenatal (n = 5 factors), before 7 years (n = 6 factors), and after 7 years (n = 5 factors). We controlled for handedness as a putative marker of prenatal androgen exposure and the possibility of mischievous responding statistically. Girls with greater maternal psychological distress since age 7 and greater pubertal body mass index were more likely to be nonheterosexual but the effect sizes were very small. Among boys there were no significant associations between any early life conditions and later sexual orientation. However, focusing on effect sizes rather than significance levels, there were small associations between preterm birth and nonheterosexuality. The results offer further evidence that psychosocial influences in the development of adolescent sexual orientation are weak or non-existent.

Keywords: Sexual orientation; homosexuality; causes; sex differences; adolescence; Millennium Cohort Study; prospective birth cohort

EARLY CONDITIONS AND SEXUAL ORIENTATION

1. INTRODUCTION

The origins of differences in human sexual orientation is an area of much scholarly debate. Both biological and environmental influences on the development of sexual orientation have been proposed, with the strength of evidence falling on "non-social" ones (including but not limited to genetic and prenatal influences; see Bailey et al., 2016 for an extensive review of this literature). An unresolved scientific question concerns the extent to which psychosocial or environmental factors are important at all, or whether there are some kind of interactive "biopsychosocial" influences upon later sexual orientation. Environmental factors tend to be understudied as well as being viewed as being more stigmatizing of nonheterosexuality (LeVay, 2016). However it should be possible to study the multifactorial origins of human sexual orientation without casting moral, social or political judgements based on theories about causation. Studies on the causes of sexual orientation also suffer persistent methodological problems. Cross-sectional designs are often used and cannot test for causal pathways, retrospective designs are susceptible to reporting biases, and studies rarely test a large range of theoretically important biological and environmental factors together. Yet the existence of multifactorial influences, including environmental ones, is suggested by twin studies. These indicate that less than a third of the variation in sexual orientation is due to genetics and that concordance rates for homosexuality are low among identical twins (approximately 24% across men and women; Bailey et al., 2016). Thus, postnatal environmental influences (often non-shared) in sexual orientation should be appreciable.

One study has attempted to test the relationship between multiple prenatal and postnatal early life factors and later adolescent sexual orientation in a prospective birth cohort (Xu, Norton, Rahman, 2019). This was done based on a life history framework. Xu et al. (2019) used a longitudinal design to get closer to causal pathways, tested three theoretically important developmental stages (prenatal and two postnatal age ranges), and controlled for putative markers of prenatal androgen exposure. That study reported that low birthweight and shorter breastfeeding duration were found to be associated with later nonheterosexuality among boys. Among girls, a combination of factors measured prenatally and later in childhood including parental absence, low prenatal family socioeconomic position (SEP) and poorer parent-child relationship were found to be associated with later nonheterosexuality (Xu et al., 2019). The overall aim of the present study is test whether these findings could be replicated in another longitudinal birth cohort in the United Kingdom, the Millennium Cohort Study (MCS). Reproducibility in psychology is a critical issue and so we offer our study in the spirit of encouraging reproducibility in developmental and psychobiological sciences.

EARLY CONDITIONS AND SEXUAL ORIENTATION

Previously, we used life history theory as a framework for understanding the role of environmental factors in sexual orientation development (Del Giudice, Gangestad, & Kaplan, 2015; Xu et al., 2019). While exclusive homosexuality does not directly enhance reproductive success, prevalence data indicates that occasional same-sex behaviors and attractions (a broader phenotype of "nonheterosexuality") are more common than substantial or exclusive homosexuality (Gates, 2011). This allows for some direct reproduction because heterosexual contacts are common in a subset of nonheterosexuals. Nonheterosexuality among adolescents may represent an earlier onset of sexual maturity, with some evidence suggesting gay and bisexual males have earlier pubertal onset. However, the relationship between sexual orientation and retrospectively recalled sexual maturation indicators among adults is inconsistent (Bogaert, 2010; Bogaert & Friesen, 2002). Life history frameworks may also help integrate competing developmental explanations or offer an empirical counterweight to influential theories of sexual orientation. One such theory is the prenatal androgen model which proposes that atypical prenatal androgen exposure during critical periods is associated with nonheterosexuality (Ellis & Ames, 1987). A large body of research on the sexual orientation patterns of women with congenital adrenal hyperplasia (a condition associated with elevated levels of prenatal androgens), the link between sexual orientation and digit ratio (a marker ascribed to the actions of prenatal androgens), associations between sexual orientation and gender nonconformity, and cross-sexed patterns of neurocognitive performance among nonheterosexual men and women offer support to the prenatal androgen theory (Breedlove, 2017; Skorska & Bogaert, 2017c; Xu, Norton, & Rahman, 2017).

Several candidate early life factors are plausibly related to the development of sexual orientation. These include birthweight, sibling sex composition, and body size which are theorized to be due to prenatal androgen or maternal immunity processes, or are indicators of low parental investment. Low birthweight is associated with faster life history among women and male sexual orientation on its own or through its interaction with number of older brothers (Blanchard & Ellis, 2001; Nettle, Coall, & Dickins, 2011; Xu et al., 2019). Homosexual men have greater numbers of older brothers compared to heterosexual men, an observation known as the fraternal birth order effect (FBO; Blanchard, 2018). Studies have reported that homosexual men or feminine boys (boyhood femininity is treated as an indicator of probable adulthood nonheterosexuality; Bailey & Zucker, 1995) with older brothers had lower birthweights than heterosexual men or control boys (Blanchard & Ellis, 2001; Blanchard et al., 2002). This is theorized to be due to a maternal immune response to male fetuses which decreases the birthweight of subsequent male fetuses as well as increases

their odds of nonheterosexuality. One study has identified PCDH11Y and NLGN4Y as potential Y-linked antigens which may trigger maternal immune reactions (Bogaert et al., 2018). However, other research suggests first-born homosexual males also have lower birthweights pointing to a distinct pattern of maternal immunity mechanisms different from that one associated with FBO (Skorska, Blanchard, VanderLaan, Zucker, & Bogaert, 2017). Xu et al. (2019) also found lower birthweight among nonheterosexual boys was unrelated to number of siblings. Low birthweight infants may attract less parental investment or care which could cascade into differences in sexual behavior. Some studies have also indicated that homosexual men are shorter and lighter than heterosexual men (comparable findings for homosexual compared to heterosexual women are weaker; Bogaert, 1998, 2010; Skorska & Bogaert, 2017a; cf. Bogaert & Friesen, 2002). These associations do not seem related to physical and psychosocial stress or nutrition levels during adolescence, and so point to potential prenatal mechanisms (Skorska & Bogaert, 2017b).

The evidence for psychosocial influences on the development of sexual orientation is weak (Bailey et al., 2016). However, such studies are limited by methodological factors mentioned earlier. One proposed psychosocial factor is parent-child relationship. Retrospective studies show weak associations between parent-child relationships and sexual orientation which become non-significant when controlling for gender nonconformity (a strong childhood predictor of later nonheterosexuality; Bailey & Zucker, 1995; Li, Kung, & Hines, 2017) (Bell, Weinberg, & Hammersmith, 1981). But poorer parent-child relationship was found to be associated with later nonheterosexuality among girls in one prospective study even after controlling for gender nonconformity (Xu et al., 2019). As pre-nonheterosexual children are likely to be gender nonconforming and show elevated rates of separation anxiety, these factors may negatively influence relationships with parents (Kane, 2006; VanderLaan, Gothreau, Bartlett, & Vasey, 2011). Studies of children raised by nonheterosexual parents show no differences in their sexual orientation compared to those reared by heterosexual parents; strong evidence against parental psychosocial influences (Bailey et al., 2016). One large Danish cohort study using prospective methods reported that having older mothers, divorced parents, absent fathers, and being the youngest child was associated with same-sex marriage (a proxy for sexual orientation) among men. For women, maternal death during adolescence and being the only or youngest child, or the only girl in the family increased the likelihood of same-sex marriage (Frisch & Hviid, 2006). Another longitudinal study reported that peer influences (e.g., transmission via social networks) had no effect on same-sex attraction among adolescent (Brakefield et al., 2014). An important

caveat in this body of research is that psychosocial factors may be stronger in female than male sexual orientation. This is hypothesized to be due to the greater malleability of female sexual orientation (Bailey et al., 2016).

Other indicators of early life conditions and parental investment including preterm birth, having older parents, shorter duration of breastfeeding, and psychosocial adversities such as poor maternal mental health (e.g., anxiety and depression) and low family SEP. These factors have been associated with faster male and female sexual life histories (Nettle et al., 2011; Wehkalampi et al., 2011; Xu, Norton, & Rahman, 2018) and sexual orientation although differently for males and females. Shorter breastfeeding duration was found to be associated with later nonheterosexuality among boys (Xu et al., 2019). Some studies show that having older mothers was associated with male nonheterosexuality (Xu et al., 2018) or same-sex marriage in men (Frisch & Hviid, 2006) but not others (Blanchard & Bogaert, 1996; Xu et al., 2019). Parental absence and lower family SEP were found to be associated with later nonheterosexuality in girls (Xu et al., 2019).

In the current study, we use data from a prospective birth cohort study in the United Kingdom, the MCS, to test whether a range of early life and psychosocial factors were associated with later adolescent sexual orientation. The longitudinal design will permit better tests of causal pathways. The main research aim was to replicate the results reported by Xu et al. (2019) in an independent sample. Similar to that study, the MCS measured multiple early life factors (see Xu et al., 2019 for details). However, the MCS did not measure several variables in Xu et al (2019) including childhood gender nonconformity and digit ratios.

As in Xu et al. (2019) we predicted that several developmental stages may be important sensitive periods for the influences of early life and psychosocial factors upon emerging sexual orientation. Accordingly, we classified the factors of interest into three relevant developmental periods, including prenatal, postnatal before 7 years of age, and postnatal after 7 years of age. Finally, we also controlled for handedness as a putative marker of prenatal androgen exposure, especially for men (e.g., Skorska & Bogaert, 2017c). It is important to note that greater non-right handedness among both homosexual men and women may point to a general mechanism, such as developmental instability (Lalumiere, Blanchard, & Zucker, 2000). Nevertheless, as prenatal androgen theory is currently the dominant model of sexual orientation development, and others have also used markers such as handedness to help capture its contribution, we included a test of it here. MCS measured sexual attraction at age of 14 years. While this is early, it does appear appropriate to begin measuring sexual orientation at this age. Men and women appear to recall first having feelings of sexual

attraction at approximately age 10 (McClintock & Herdt, 1996). Another study reported a mean age of self-reported first awareness of same-sex attraction at approximately 13 years (Floyd & Bakeman, 2006; Floyd & Stein, 2002).

In this study, we tested the association between early life and psychosocial factors and later sexual orientation in boys and girls separately. We hypothesized that prenatal early life factors would be associated with nonheterosexuality in both boys and girls, and postnatal early life factors would be associated with nonheterosexuality in girls since their sexual orientation is more environmentally influenced.

2. METHOD

2.1 Participants

Participants were part of the MCS which is an ongoing and nationally representative UK longitudinal observational study. Participants eligible for the study were all children born between 1st September 2000 and 31th August 2001 in England and Wales, and between 24th November 2000 and 11th January 2002 in Scotland and Northern Ireland who were alive, living in the UK at age 9 months, and listed on the Child Benefit Records. In order to ensure adequate representation of ethnic minority and children living in disadvantaged areas, a random sample was collected from the eligible population using a disproportionate stratified cluster sampling design. The eligible population was stratified by UK country (England, Wales, Scotland, and Northern Ireland), and further stratified by ethnic group composition (where at least 30 % of the total population fell into the two categories “Black” or “Asian”) and child poverty index (Plewis, 2007). The initial sample recruited 18,827 children from 18,552 families. Some families with eligible children who had moved into the sampling wards after their initial registration on the Child Benefit system were not recruited at the first occasion. Accordingly, 1,389 new families were recruited on the second occasion. Six waves of the MCS cohort have been carried out so far including at age nine months, three years, five years, seven years, eleven years, and fourteen years old. The response rates were relatively stable at approximately 70%. For more details, see Connelly & Platt (2014). The study website contains details of all the data, which are available through a fully searchable data dictionary: http://www.cls.ioe.ac.uk/mcs. Informed parental consent was obtained at each stage of the study (see Shepherd, 2012), and ethical approval for the study reported here was obtained from a local university research ethics subcommittee. The current study analyzed MCS data reported by parents and children across different waves. Adolescents who reported a valid response of sexual orientation at 14 years old were included, N = 9,795 (4,911 boys and 4,884 girls).

No formal power calculation could be conducted because the study is based on secondary analysis. However, it is possible to consider power to detect a meaningful effect. At the 0.5% significance level, the sample size allows for the detection of an odds ratio of 2.57 where the proportional odds assumption holds for a continuous predictor variable with 80% power based on power simulation (Benjamin et al., 2018; Feiveson, 2002). Converted to the Cohen's *d* metric, an odds ratio of 2.57 equates to a Cohen's *d* of .52, which is generally considered to be a medium effect (Borenstein, Hedges, Higgins, & Rothstein, 2009). Thus, despite the low number of nonheterosexuals in the sample, power to detect meaningful effects is acceptable. In line with current debates on reproducibility and statistical significance, we encourage readers to consider the effect sizes of our odds ratios (Lakens & Evers, 2014).

2.2 Measures

2.2.1 Sexual orientation

At 14 years old, adolescents were required to report their sexes and answer the questions: "Have you ever been attracted to a male" and "Have you ever been attracted to a female" from *yes, no, do not know, or do not want to answer*. This was done via computer to promote disclosure of sensitive personal information. Measures of being attracted to males and females in separate items have been used in large studies of adolescents (e.g., Russell & Consolacion, 2003). Such measures of sexual attractions were also found to show expected associations with sex of sexual partners (Lindley, Walsemann, & Carter 2012). Assessing sexual attraction, compared to identity and sexual behavior, is considered an optimal approach to measuring sexual orientation among adolescents and results in lower nonresponse rates (Austin, Conron, Patel, & Freedner, 2006; Saewyc et al., 2004). Adolescents who chose "*do not know*" (n = 35), "*do not want to answer*" (n = 90), or chose "*no"* to both questions (not attracted to either sex, n = 1,443) were excluded from analyses. As bisexuals may differ from homosexuals in some components of sexual orientation, we treated them as separate groups. Accordingly, adolescents who chose "*attracted to the other-sex but not attracted to the same-sex"* were coded as heterosexual, those who chose "*attracted to both other-sex and same-sex"* were coded as bisexual, and those who chose "*attracted to the same-sex but not attracted to the other-sex"* were coded as homosexual. As a result, 4,765 heterosexual boys (97.02%), 125 bisexual boys (2.55%), 21 homosexual boys (0.43%), 4,404 heterosexual girls (90.18%), 451 bisexual girls (9.23%), and 29 homosexual girls (0.59%) were included.

2.2.2 Body size

Birthweights (kgs) were obtained during interviews with the main carers (usually adolescents' mothers) and approximately 90% of recalled birthweights were validated from Parent Held Child Health Records which the majority of the cohort used. At 14 years old adolescents gave their height and weight, to generate body mass index (BMI).

2.2.3 Gestational age

Gestational age at birth was derived from the estimated date of delivery reported by main carers and was validated from Parent Held Child Health Records. Adolescents were categorized into three gestational age groups: preterm birth (< 37 weeks' gestational age), term birth (37 - 41 weeks' gestational age), and post-term birth (> 41 weeks' gestational age) (Savitz et al., 2002).

2.2.4 Parental age

At 9 months old, adolescents' mothers and fathers reported their ages when the adolescent was born. We coded this information into two variables: maternal age and paternal age at birth.

2.2.5 Maternal psychological distress

At five waves, Kessler Scale (K6) was used to measure maternal psychological distress. The Kessler Scale is a validated self-report inventory with six items assessing indicators of psychological distress during the past 30 days on a 5-point scale ranging from 1 = *all of the time* to 5 = *none of the time* (Kessler et al., 2002). K6 also has good reliability and validity (Mewton et al., 2016; Mitchell & Beals, 2011). An example item is "During the last 30 days, about how often did you feel hopeless?" The total score was calculated stratified by wave, with a higher score indicating greater maternal psychological distress. We recoded this into two variables: maternal psychological distress before 7 years of age and maternal psychological distress since 7 years of age. To do this, the average of maternal psychological distress measured at 3 and 5 years old was computed and coded as maternal psychological distress before 7 years of age since they were correlated (r = .57). We did similarly for maternal psychological distress measured at 7, 11, and 14 years old (with r ranging from .53 to .62).

2.2.6 Older siblings

At 9 months old, the household members reported their relationships to the adolescents. The MCS team created a derived variable about the numbers of older siblings who lived with the adolescents, including full brothers and sisters, maternal and paternal half-brothers and half-sisters, step-brothers and step-sisters, fostered children, and adopted children.

2.2.7 Family structure changes

At each wave, the household members reported their relationships to adolescents and their genders. The MCS team created a derived variable about parental presence in the household. Father absence and mother absence were recoded into two variables with three categories: father/mother absence before 7 years of age, father/mother absence since 7 years of age, and father/mother present. Due to low rates of mother absence, it was necessary to combine these variables to indicate parental absence (see missing data section).

2.2.8 Duration of breastfeeding

When adolescents were 9 months, 3, and 5 years old, their main carers reported whether their children were breast-fed (*yes* or *no*) and the duration of breastfeeding in months. Duration of breastfeeding in months was used in the analysis, and adolescents who were not breast-fed received a score of 0 on this variable. Maternal reports of breastfeeding initiation and duration appear accurate and reliable (Li, Scanlon, & Serdula, 2005).

2.2.9 House moves

At five waves, the adolescents' main carers reported whether the current address was the same as that at the last interview and when they moved to the current address. We recoded this information into two binary variables: house move before 7 years of age, and since 7 years of age. Repetitive house moves may be an indicator of early psychosocial disruption or family environment and SEP (Gattis, 2009).

2.2.10 Parent-child relationship

When adolescents were 3 years old, two subscales of Child Parent Relationship Scale were used to measure parents' perceptions of their relationship with their children (Pianta, 1992). The scale is a validated self-report inventory with good reliability and validity (Driscoll & Pianta, 2011). The conflict subscale consists of eight items which measure negative parent-child relationships, while the closeness scale consists of seven times which measure positive parent-child relationships. The fifteen items were rated on a 5-point scale ranging from 1 = *definitely does not apply* to 5 = *definitely applies*. An example item is "It is easy to be in tune with what *child's name* is feeling". The total score was used in the analysis, with a higher score indicating a better relationship. Both the adolescents' mothers and fathers reported their relationship with adolescents (r = .32). The average of both parents' scores was used in the analysis for adolescents with both parents' scores available, while either mother's or father's score was used in the analysis for adolescents with only one parent's score available.

2.2.11 Family SEP

Family SEP was assessed via parents' education, parents' occupation, and household income. Since life history theory focuses on adverse life conditions early in life, we used relevant

indicators of family SEP (lowest occupation and lowest household income). When adolescents were 9 months, their parents reported their highest educational qualifications (*Higher degree*, *First degree*, *Diplomas in higher education, A/AS/S levels*, *O level/ GCSE grades A-C*, *GCSE grades D-G*, *other academic qualifications, and none of these qualifications*). Parents who chose *other academic qualifications* were coded as missing.

At each wave, adolescents' parents reported their occupation. The National Statistics Socio-economic Classification (NS-SEC 7 classes) was used to categorize occupation type. We recoded this into four variables, mother's lowest occupation before adolescents were 7 years old, and father's lowest occupation before adolescents were 7 years old, mother's lowest occupation since adolescents were 7 years old, and father's lowest occupation since adolescents were 7 years old.

Also at each wave, adolescents' parents reported their annual incomes which were used to create a household annual income variable. To measure income inequalities, the MCS team used quintiles of family income after adjustment using the modified OECD scale (Hansen, 2012). This scale takes the number of household members into account by setting the family's needs relative to those of a couple with no children (Hansen, 2012). We recoded this into two variables, lowest household income before 7 years of age, and since 7 years of age.

Since these indicators of family SEP are correlated (polychoric correlation from .30 to .59), summary scores incorporating these indicators were constructed: family SEP before 7 years of age and family SEP since 7 years of age. We applied polychoric principal component analysis, and used the loadings on the first principal component as item weightings to generate a summary score for each developmental stage (Vyas & Kumaranayake, 2006). A higher score indicates higher family SEP (Supplemental Table 1 for the factor loadings). The first component could explain 57.97% and 55.22% of the variation in family SEP before 7 years of age and family SEP since 7 years of age, respectively.

2.2.12 Handedness

At 14 years old, adolescents were required to answer the questions: "With which hand do you write best" from *right hand, left hand, and either hand*. Such a single-item handedness measurement was 97% concordant with a multi-item handedness measurement for dichotomous classification (Coren, 1993), and does not affect the relationship between handedness and sexual orientation (Lalumiere et al., 2000).

2.3 Procedure

2.3.1 Missing data

The variables had 0.01% - 50.24% missing information in the analysis sample (Table 1 and 2). This was handled using multiple imputation stratified by sex. Prior to imputation, we examined potential missing data mechanisms using logistic regression to assess whether the observed variables predict missingness. The results showed that the data were unlikely to be missing completely at random (e.g., family SEP and house move before 7 years of age, and parental absence predicted the missingness of family SEP since 7 years of age among boys).

For the imputation model, recommendations for prospective cohort studies instruct that all variables in the analysis model should be included (White, Royston, & Wood, 2011). Thus, the outcome variable (sexual orientation), predictors (early life and psychosocial factors), and covariate (handedness) were included. Recommendations also suggest that the number of imputations should be at least as large as the percentage of missing data (White et al., 2011). Thus, we used 51 imputations. A chained equations algorithm (MICE) model was used since our sample had a combination of continuous and categorical variables. The continuous variables included here were not normally distributed (Shapiro-Francia test showed that all ps $< .001$). Thus, a predictive mean matching approach was used since this makes no distributional assumptions.

Imputation for mother absence failed to converge due to small cell sizes. Previously we found that the association between parental absence and sexual outcomes did not differ across type of parental absence (Xu et al., 2018). Thus, we were forced to combine father absence and mother absence into one variable parental absence (either parent absence before 7 years, either parent absence since 7 years, and both parents presence). Trace plots and other diagnostics provided no cause for concern regarding the imputed values. Normally we would conduct sensitivity analysis comparing analyses based complete-case and imputed data. However, due to the relatively high proportion of missing data in the sample this was not possible.

2.4 Data Analysis

Analyses were performed in Stata 15.0 and conducted separately for boys and girls. First, a univariate ordered logistic regression was estimated with sexual orientation (heterosexual, bisexual or homosexual) regressed on each early life and psychosocial variable to determine the unadjusted association. Then a three-step hierarchical multivariable ordered logistic regression was estimated with early life and psychosocial factors entered in a sequential manner based on the age period at which they were measured and controlling for handedness. In the first step, prenatal early life factors (e.g., birthweight) followed by early life and

psychosocial factors before 7 years in the second step, and the same factors since 7 years in the third step.

Studies which measure adolescent sexual orientation may be susceptible to mischievous responding (Savin-Williams & Joyner, 2014). In order to provide a possible way to control for this we used the method outlined by Robinson-Cimpian (2014). Specifically, we used a probability-based measure to calculate a screener-indexing value which was included as a covariate in the regression models to account for the possible influence of mischievous responding on sexual orientation.

The *mimrgns* command in Stata was further used to calculate the average predicted probability of being homosexual for each significant predictor and covariate in the final model generated by the third step of the multivariable ordered logistic regression. Predicted probabilities for each continuous variable were computed using the 25th/50th/75th percentile and observed values for the remaining variables in the model. In addition, we computed the predicted probability of being nonheterosexual for adolescents with all the significant predictor factors (and the covariate) present, and for adolescents with none of these significant factors. The significant continuous variables were set to the 25th/75th percentile for presence (75th for variables with odds ratios greater than 1 and 25th for variables with odds ratios less than 1) and 50th percentile for absence, and the remaining variables were set to the observed values.

The ordered logistic regression models assume proportional odds. In other words, the log-odds ratio for the predictor in a logistic model where the outcome is heterosexual vs bisexual/homosexual is equivalent to the log-odds ratio for the model where the outcome is heterosexual/bisexual vs homosexual. The Brant test was used iteratively to assess the likelihood that this assumption held for each predictor (Brant, 1990). Where the test was significant at the 5% level the assumption was relaxed for that predictor. Thus, one odds ratio is presented where the proportional odds assumption held and two are presented where it did not. Homosexual and bisexual individuals may differ in some components of sexual orientation and so the outcome variable in the ordered regressions may not always be ordinal. To evaluate the robustness of our estimates to varying conceptualizations of sexual orientation, we also estimated logistic regression models where the outcome was heterosexual vs bisexual/homosexual, and in multinomial logistic regression where the outcome is heterosexual vs bisexual and heterosexual vs homosexual. Here, no assumption about the outcome being ordinal or the proportionality of the odds is made (Supplemental Tables 2 to 5).

3. RESULTS

3.1 Boys

There were no significant relationships between early life and psychosocial factors and later nonheterosexuality among boys (Table 3 and Table 4). Maternal psychological distress since 7 was significantly associated with nonheterosexual orientation in the univariate models, odds ratio = 1.055, 95% confidence interval (CI) = 1.008 - 1.103, $p < .05$. However, this association was reduced to non-significance in the multivariable regressions, odds ratio = 1.056, 95% CI = 0.978 – 1.141, $p = .165$. In terms of effect size, there was indication of a small association between preterm birth and later nonheterosexuality among boys but this was not significant.

3.2 Girls

Greater maternal psychological distress since 7 (odds ratio ranging from 1.056 to 1.063, all *p*s < .05) and greater pubertal body mass index (odds ratio ranging from 1.034 to 1.041, all *p*s < .01) were significantly associated with later nonheterosexuality in both univariate and multivariable models (Table 3 and Table 5). In univariate models, girls with older mothers at birth (odds ratio = 1.021, 95% CI = 1.004 - 1.038, $p < .05$), experiencing longer breastfeeding duration (odds ratio = 1.021, 95% CI = 1.006 - 1.037, $p < .01$), and greater maternal psychological distress before 7 (odds ratio = 1.062, 95% CI = 1.032 - 1.092, $p < .001$, were significantly more likely to report being nonheterosexual. However, these associations were reduced to non-significance in multivariable models. To promote clarity, the significant odd ratios (relative difference) from the third step of the multivariable ordered logistic regression were transformed to average marginal effects (absolute difference). Girls with mothers experiencing greater psychological distress since 7 (75th percentile) had a 0.62%, 95% CI = 0.40% - 0.85% probability of being homosexual, and girls with greater pubertal body mass index (75th percentile) had a 0.63%, 95% CI = 0.40% - 0.86% probability of being homosexual. The predicted probability of being homosexual for girls with greater maternal psychological maternal distress since 7 and pubertal body mass index was 0.66%, 95% CI = 0.42% - 0.91%, while girls with none of these had a 0.53%, 95%CI = 0.34% - 0.73% probability of being homosexual (Figure 1).

4. DISCUSSION

In general, we were unable to replicate the pattern of results reported by Xu et al. (2019) in an independent, prospective birth cohort sample. In hierarchical multivariable models, we found that greater maternal psychological distress since 7 and greater pubertal body mass index predicted nonheterosexuality among girls but failed to find any significant effects of parental

absence since birth, low prenatal family SEP, and low parent-child relationship scores as revealed in Xu et al. (2019). The results for girls also suggest sexual orientation may be weakly associated with psychosocial factors at later developmental stages rather than restricted to the prenatal or early postnatal period. Among boys, we did not find any significant associations, including associations between low birthweight, shorter breastfeeding duration, and later nonheterosexuality reported in Xu et al. (2019). In terms of effect size, there was some evidence for an association between preterm birth and later sexual orientation among boys. However, this was not statistically significant. The overall pattern of odd ratios was small in size and with wide confidence intervals (with zero values being contained).

The results offer further evidence that psychosocial influences in the development of male adolescent sexual orientation are weak or nonexistent. They appear weak but may be present in female adolescent sexual orientation (Bailey et al., 2016). The findings also, tentatively, support the notion that male and female sexual orientation have somewhat different developmental origins. This is consistent with twin research indicating a small influence of shared environmental factors (including parental and familial social ones) on female sexual orientation (Bailey et al., 2016; Långström, Rahman, Carlström, & Lichtenstein, 2010). They are also supportive of the notion that female sexual orientation shows greater variability and change possible in response to environmental factors (Baumeister, 2000). The very small associations also suggest that other causal factors co-occurring between our predictor variables and later sexual orientation may be important, e.g., common genetic effects (Barbaro et al., 2017; Burri, Cherkas, Spector, & Rahman, 2011). These common genetic (or other) third variables may be different for males and females. Our findings do not necessarily shed further light on the issue of whether sexual orientation is innate or not. Early development is not necessary evidence of innateness, any more than late development is evidence against it. Nevertheless, our findings are more consistent with non-social explanations for the development of sexual orientation than social ones (Bailey et al., 2016).

The current study had several important strengths. These include a prospective design in a well-characterized cohort, good statistical power, and with the predictor variables of interest (and the covariate) measured before sexual orientation. The range of factors of interest also closely match those reported in Xu et al. (2019) as does the use of three theoretically relevant developmental stages. Our study is also among the first in the area of sexual orientation development to attempt to control for potential mischievous responding using techniques

developed by scholars in epidemiology and education sciences (Robinson-Cimpian, 2014; Savin-Williams & Joyner, 2014). The prospective nature of the study reduces the risk of recall biases and provides a better test of causal pathways. The design also reduces the likelihood of reverse causation between early life and psychosocial factors and later sexual orientation.

However, there are several limitations. Firstly, the sample sizes of nonheterosexual boys and girls was small. This problem is common to sexual orientation research given the low population prevalence of nonheterosexuality (Bailey et al., 2016). In addition, small increases in the numbers of nonheterosexual among small cell sizes in the predictor variables could result in inflated odds ratios. However, inflated odds ratios were not problems in the present study. Secondly, there is potential for misclassification to occur given that sexual orientation was measured at 14 years old. Adolescents at the age of 14 may be in the early stages of sexual orientation formation and may change their sexual orientation reports if we reassessed the cohort at later ages (Austin et al., 2009), which may even produce somewhat different results. The potential for misclassification of sexual orientation may be one explanation for some of the null results. However, men and women do appear to recall their first sexual attractions at approximately age 10 (McClintock & Herdt, 1996) while other studies report initial awareness of same-sex attraction at approximately 13 years (Floyd & Bakeman, 2006; Floyd & Stein, 2002). Thus, it does appear appropriate to begin measuring emerging sexual orientation at 14 years. Thirdly, the measure asked adolescents about their sexual attractions and not sexual identity labels or sexual experiences. Sexual attractions are considered the best indicator of sexual orientation among adolescents when other dimensions (identity and sexual experience) are unavailable (Austin et al., 2006; Saewyc et al., 2004). Finally, the MCS study sample also suffers from additional measurement issues. The number of older siblings in the MCS cohort included biological, half-brothers, step brothers, fostered brothers, and adopted brothers and sisters who lived with the adolescents. Furthermore, we were unable to separate maternal and paternal absence because the imputation for mother absence failed to converge due to low rates. We were also unable to control for unobserved confounders or unmeasured genetic and environmental confounds that load simultaneously on our predictors, covariate and outcome variables (Zietsch & Sidari, 2019).

In conclusion, the present study was unable to replicate the full pattern of results reported in Xu et al. (2019). However, associations between maternal psychological distress, pubertal body mass index and later female adolescent sexual orientation were found. The findings, consistent with prior research, do not offer compelling evidence for a role for

specific early life conditions and psychosocial influences in adolescent sexual orientation. Future studies should test for third factors and genetic confounds as well as change and stability in sexual orientation at later ages and into early adulthood.

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TABLE 1 Descriptive statistics for early life conditions, covariates, and screening items for mischievous responding among boys.

	Sexual orientation		
Variable	Heterosexual	Bisexual	Homosexual
Prenatal early life factors			
Birthweight (in kilograms)			
N	4583	117	21
M (*SD*)	3.42 (0.60)	3.44 (0.67)	3.35 (0.64)
Gestational age *N* (%)			
Preterm birth	366 (8.06)	13 (11.11)	1 (4.76)
Term birth	3610 (79.50)	88 (75.21)	17 (80.95)
Post-term birth	565 (12.44)	16 (13.68)	3 (14.29)
Maternal age (in years)			
N	4591	117	21
M (*SD*)	29.07 (5.73)	29.45 (6.45)	29.00 (6.24)
Paternal age (in years)			
N	3944	101	19
M (*SD*)	32.35 (5.95)	32.82 (7.17)	32.74 (5.09)
Number of older siblings			
N	4596	117	21
M (*SD*)	0.90 (1.04)	0.83 (0.94)	0.86 (1.15)
Early life factors before 7 years			
Duration of breastfeeding (in months)			
N	4556	115	21
M (*SD*)	3.63 (6.01)	3.44 (6.22)	2.42 (3.56)
Parent-child relationship[a]			
N	4150	113	18
M (*SD*)	63.30 (6.20)	62.67 (6.68)	63.42 (8.86)
Maternal psychological distress before adolescents were 7[b]			
N	3707	97	18
M (*SD*)	9.04 (3.15)	9.62 (3.44)	9.97 (3.56)
Family socioeconomic position before adolescents were 7[c]			
N	2588	63	10
M (*SD*)	6.65 (2.52)	6.55 (2.76)	7.16 (2.24)
House moves before adolescents were 7 *N* (%)			
No	2729 (57.85)	74 (60.16)	13 (61.90)
Yes	1988 (42.15)	49 (39.84)	8 (38.10)
Early life factors since 7 years			
Maternal psychological distress since adolescents were 7[b]			
N	3666	95	15
M (*SD*)	9.52 (3.32)	10.26 (3.77)	11.07 (3.98)
Family socioeconomic position since adolescents were 7[d]			
N	2415	57	11
M (*SD*)	6.73 (2.35)	6.83 (2.50)	7.29 (1.80)
Pubertal body mass index			
N	4657	124	21
M (*SD*)	20.88 (3.89)	21.27 (4.62)	20.81 (5.11)
House moves since adolescents were 7 *N* (%)			
No	3374 (70.88)	90 (72.00)	14 (66.67)
Yes	1386 (29.12)	35 (28.00)	7 (33.33)

Variable	Sexual orientation		
	Heterosexual	Bisexual	Homosexual
Early life factors since 7 years			
Father absence *N* (%)			
Father absence before adolescents were 7	1194 (25.06)	37 (29.60)	4 (19.05)
Father absence since adolescents were 7	641 (13.45)	14 (11.20)	8 (38.10)
Father presence	2930 (61.49)	74 (59.20)	9 (42.85)
Mother absence *N* (%)			
Mother absence before adolescents were 7	48 (1.01)	2 (1.60)	0 (0.00)
Mother absence since adolescents were 7	158 (3.32)	6 (4.80)	0 (0.00)
Mother presence	4559 (95.67)	117 (93.60)	21 (100.00)
Covariate			
Handedness *N* (%)			
Right-handed	4063 (85.28)	108 (86.40)	19 (90.48)
Both	59 (1.24)	3 (2.40)	1 (4.76)
Left-handed	642 (13.48)	14 (11.20)	1 (4.76)
Screening items			
A member of a street gang *N* (%)			
No	4604 (96.82)	119 (95.20)	21 (100.00)
Yes	151 (3.18)	6 (4.80)	0 (0.00)
Have difficulty hearing or use a hearing aid *N* (%)			
No	4616 (97.08)	117 (94.35)	18 (85.71)
Yes	139 (2.92)	7 (5.65)	3 (14.29)
Have difficulty seeing *N* (%)			
No	3509 (93.92)	71 (92.21)	10 (90.91)
Yes	227 (6.08)	6 (7.79)	1 (9.09)
Have been arrested by a police officer *N* (%)			
No	4695 (98.66)	123 (98.40)	20 (95.24)
Yes	64 (1.34)	2 (1.60)	1 (4.76)
Never have breakfast over a week *N* (%)			
No	4495 (94.45)	114 (91.20)	17 (80.95)
Yes	264 (5.55)	11 (8.80)	4 (19.05)
Usually go to sleep after midnight on a school night *N* (%)			
No	4446 (93.62)	110 (88.00)	17 (80.95)
Yes	303 (6.38)	15 (12.00)	4 (19.05)
Being picked on or hurt by their siblings most days *N* (%)			
No	4313 (90.69)	108 (87.10)	18 (85.71)
Yes	443 (9.31)	16 (12.90)	3 (14.29)
Stayed out after 9:00pm without parents knowing ten or more times in the past month *N* (%)			
No	4473 (93.99)	117 (95.12)	18 (85.71)
Yes	286 (6.01)	6 (4.88)	3 (14.29)

Note: [a]The range is from 15 to 75.

[b]The range is from 6 to 30.

[c]The range is from 0 to 11.69.

[d]The range is from 0 to 11.58.

TABLE 2 Descriptive statistics for early life conditions, covariates, and screening items for mischievous responding among girls.

	Sexual orientation		
Variable	Heterosexual	Bisexual	Homosexual
Prenatal early life factors			
Birthweight (in kilograms)			
N	4267	428	29
M (*SD*)	3.30 (0.56)	3.31 (0.59)	3.10 (0.73)
Gestational age *N* (%)			
Preterm birth	285 (6.72)	28 (6.60)	4 (14.29)
Term birth	3423 (80.77)	335 (79.01)	22 (78.57)
Post-term birth	530 (12.51)	61 (14.39)	2 (7.14)
Maternal age (in years)			
N	4269	428	29
M (*SD*)	29.00 (5.74)	29.44 (6.21)	28.34 (5.57)
Paternal age (in years)			
N	3675	365	25
M (*SD*)	32.30 (5.99)	32.89 (6.35)	32.76 (6.72)
Number of older siblings			
N	4270	428	29
M (*SD*)	0.90 (1.02)	0.84 (1.01)	1.17 (1.42)
Early life factors before 7 years			
Duration of breastfeeding (in months)			
N	4249	423	28
M (*SD*)	3.62 (5.82)	4.21 (6.09)	4.01 (6.05)
Parent-child relationship[a]			
N	3850	403	24
M (*SD*)	63.93 (5.82)	63.68 (6.28)	63.67 (5.80)
Maternal psychological distress before adolescents were 7[b]			
N	3390	351	22
M (*SD*)	8.93 (3.12)	9.73 (3.61)	9.45 (4.01)
Family socioeconomic position before adolescents were 7[c]			
N	2375	240	16
M (*SD*)	6.54 (2.55)	7.13 (2.57)	6.44 (3.08)
House moves before adolescents were 7 *N* (%)			
No	2533 (58.07)	243 (54.61)	16 (55.17)
Yes	1829 (41.93)	202 (45.39)	13 (44.83)
Early life factors since 7 years			
Maternal psychological distress since adolescents were 7[b]			
N	3440	366	21
M (*SD*)	9.51 (3.25)	10.56 (3.83)	10.70 (3.81)
Family socioeconomic position since adolescents were 7[d]			
N	2162	217	12
M (*SD*)	6.75 (2.36)	7.37 (2.21)	7.56 (2.81)
Pubertal body mass index			
N	4164	421	26
M (*SD*)	21.90 (4.04)	22.63 (4.18)	22.34 (4.57)
House moves since adolescents were 7 *N* (%)			
No	3107 (70.71)	295 (65.70)	18 (62.07)
Yes	1287 (29.29)	154 (34.30)	11 (37.93)

Variable	Sexual orientation		
	Heterosexual	Bisexual	Homosexual
Early life factors since 7 years			
Father absence *N* (%)			
Father absence before adolescents were 7	1117 (25.36)	130 (28.82)	11 (37.93)
Father absence since adolescents were 7	588 (13.35)	67 (14.86)	3 (10.34)
Father presence	2699 (61.29)	254 (56.32)	15 (51.73)
Mother absence *N* (%)			
Mother absence before adolescents were 7	33 (0.75)	7 (1.55)	0 (0.00)
Mother absence since adolescents were 7	126 (2.86)	15 (3.33)	1 (3.45)
Mother presence	4245 (96.39)	429 (95.12)	28 (96.55)
Covariate			
Handedness *N* (%)			
Right-handed	3899 (88.54)	398 (88.25)	22 (75.86)
Both	46 (1.04)	7 (1.55)	1 (3.45)
Left-handed	459 (10.42)	46 (10.20)	6 (20.69)
Screening items			
A member of a street gang			
No	4236 (96.32)	421 (93.56)	28 (96.55)
Yes	159 (3.68)	36 (6.44)	4 (3.45)
Have difficulty hearing or use a hearing aid			
No	4243 (96.39)	414 (92.00)	25 (86.21)
Yes	159 (3.61)	36 (8.00)	4 (13.79)
Have difficulty seeing			
No	2610 (89.85)	239 (84.75)	14 (87.50)
Yes	295 (10.15)	43 (15.25)	2 (12.50)
Have been arrested by a police officer			
No	4372 (99.34)	444 (98.45)	26 (89.66)
Yes	29 (0.66)	7 (1.55)	3 (10.34)
Never have breakfast over a week			
No	3876 (88.01)	377 (83.59)	26 (89.66)
Yes	528 (11.99)	74 (16.41)	3 (10.34)
Usually go to sleep after midnight on a school night			
No	4167 (94.68)	385 (85.56)	22 (75.86)
Yes	234 (5.32)	65 (14.44)	7 (24.14)
Being picked on or hurt by their siblings most days			
No	3831 (87.05)	376 (83.56)	23 (82.14)
Yes	570 (12.95)	74 (16.44)	5 (17.86)
Stayed out after 9:00pm without parents knowing ten or more times in the past month			
No	4241 (96.32)	440 (97.56)	29 (100.00)
Yes	162 (3.68)	11 (2.44)	0 (0.00)

Note: [a]The range is from 15 to 75.

[b]The range is from 6 to 30.

[c]The range is from 0 to 11.69.

[d]The range is from 0 to 11.58.

TABLE 3 Univariate ordered logistic regressions for sexual orientation with probability screener index as a covariate stratified by sex

	Boys (N = 4911)	Girls (N = 4884)		
Variable	OR	OR	OR[a]	OR[b]
Covariate				
Handedness (Ref = right-handed)				
Both	1.978 (0.704, 5.555)	1.414 (0.659, 3.036)		
Left-handed	0.753 (0.438, 1.295)	1.061 (0.782, 1.440)		
Early life conditions				
Gestational age (Ref = term birth)				
Preterm birth	1.366 (0.778, 2.399)	1.057 (0.721, 1.548)		
Post-term birth	1.111 (0.675, 1.827)	1.168 (0.878, 1.554)		
Birthweight	1.017 (0.767, 1.349)	1.010 (0.850, 1.199)		
Maternal age	1.018 (0.988, 1.049)	1.021*(1.004, 1.038)		
Paternal age	1.016 (0.989, 1.045)	1.016 (1.000, 1.032)		
Number of older siblings	0.912 (0.767, 1.085)	0.959 (0.871, 1.057)		
Parental absence (Ref = parents presence)				
Either parent absence before 7	1.105 (0.753, 1.622)	1.163 (0.936, 1.446)		
Either parent absence since 7	1.167 (0.722, 1.886)	1.079 (0.812, 1.434)		
Duration of breastfeeding before 7	0.994 (0.964, 1.025)	1.021**(1.006, 1.037)		
Parent-child relationship	0.994 (0.968, 1.021)	0.997 (0.980, 1.014)		
Maternal psychological distress before 7	1.042 (0.992, 1.094)	1.062***(1.032, 1.092)		
House moves before 7 (Ref = no)	0.890 (0.634, 1.250)	1.118 (0.923, 1.354)		
Family socioeconomic position before 7	1.012 (0.941, 1.088)		1.088*** (1.040, 1.138)	1.014 (0.861, 1.194)
Maternal psychological distress since 7	1.055*(1.008, 1.103)	1.063***(1.035, 1.092)		
House moves since 7 (Ref = no)	0.943 (0.654, 1.358)	1.210 (0.990, 1.480)		
Family socioeconomic position since 7	1.025 (0.944, 1.112)		1.101*** (1.046, 1.160)	1.097 (0.904, 1.331)
Pubertal body mass index	1.015 (0.975, 1.057)	1.034**(1.011, 1.057)		

Note. We applied *Brant* test to test the proportional odds assumption. If the proportional odds assumption is not violated, we reported one odds ratio in the column OR; if it is violated, we applied the *generalised ordered logit model* (*gologit2*) and reported two odds ratios in the columns OR[a] and OR[b].

[a]Heterosexual girls versus bisexual and homosexual girls.

[b]Heterosexual and bisexual girls versus homosexual girls.

*p < .05. **p < .01. ***p < .001.

TABLE 4 Three-step multivariable ordered logistic regressions for sexual orientation with probability screener index as a covariate among boys (*N* = 4911)

	Step 1	Step 2	Step 3		
Variable	OR	OR	OR	OR[a]	OR[b]
Covariate					
Handedness (Ref = right-handed)					
Both	2.075 (0.737, 5.846)	1.979 (0.699, 5.604)		1.961 (0.690, 5.578)	3.245 (0.424, 24.834)
Left-handed	0.750 (0.435, 1.290)	0.742 (0.430, 1.279)		0.754 (0.437, 1.303)	0.336 (0.045, 2.518)
Early life conditions					
Gestational age (Ref = term birth)					
Preterm birth	1.520 (0.777, 2.973)	1.516 (0.772, 2.975)	1.534 (0.781, 3.014)		
Post-term birth	1.067 (0.643, 1.770)	1.075 (0.647, 1.784)	1.072 (0.644, 1.783)		
Birthweight	1.121 (0.804, 1.561)	1.169 (0.836, 1.634)	1.164 (0.831, 1.632)		
Maternal age	1.017 (0.975, 1.060)	1.026 (0.979, 1.076)	1.025 (0.978, 1.075)		
Paternal age	1.012 (0.973, 1.052)	1.013 (0.975, 1.054)	1.012 (0.973, 1.052)		
Number of older siblings	0.867 (0.720, 1.045)	0.830 (0.676, 1.020)	0.834 (0.678, 1.025)		
Parental absence (Ref = parents presence)					
Either parent absence before 7		1.192 (0.775, 1.832)	1.158 (0.746, 1.799)		
Either parent absence since 7		1.186 (0.728, 1.934)	1.205 (0.725, 2.006)		
Duration of breastfeeding before 7		0.990 (0.959, 1.023)	0.990 (0.959, 1.023)		
Parent-child relationship		1.000 (0.972, 1.029)	1.003 (0.974, 1.032)		
Maternal psychological distress before 7		1.047 (0.991, 1.107)	1.007 (0.927, 1.094)		
House moves before 7 (Ref = no)		0.891 (0.626, 1.270)	0.888 (0.623, 1.266)		
Family socioeconomic position before 7		0.992 (0.902, 1.091)	0.932 (0.726, 1.196)		
Maternal psychological distress since 7			1.056 (0.978, 1.141)		
House moves since 7 (Ref = no)			0.932 (0.628, 1.383)		
Family socioeconomic position since 7			1.087 (0.834, 1.418)		
Pubertal body mass index			1.008 (0.966, 1.051)		

Note. We applied *Brant* test to test the proportional odds assumption. If the proportional odds assumption is not violated, we reported one odds ratio in the column OR; if it is violated, we applied the *generalised ordered logit model* (*gologit2*) and reported two odds ratios in the columns OR[a] and OR[b].

[a]Heterosexual boys versus bisexual and homosexual boys.

[b]Heterosexual and bisexual boys versus homosexual boys.

TABLE 5 Three-step multivariable ordered logistic regressions for sexual orientation with probability screener index as a covariate among girls (*N* = 4884)

	Step 1	Step 2	Step 3
Variable	OR	OR	OR
Covariate			
Handedness (Ref = right-handed)			
Both	1.416 (0.657, 3.049)	1.492 (0.686, 3.243)	1.418 (0.648, 3.105)
Left-handed	1.061 (0.781, 1.440)	1.046 (0.768, 1.426)	1.039 (0.762, 1.419)
Early life conditions			
Gestational age (Ref = term birth)			
Preterm birth	1.048 (0.681, 1.613)	1.049 (0.678, 1.623)	1.022 (0.659, 1.583)
Post-term birth	1.171 (0.876, 1.565)	1.190 (0.886, 1.597)	1.208 (0.900, 1.622)
Birthweight	0.999 (0.820, 1.217)	0.988 (0.809, 1.208)	0.953 (0.777, 1.168)
Maternal age	1.020 (0.995, 1.046)	1.011 (0.982, 1.041)	1.013 (0.983, 1.043)
Paternal age	1.007 (0.984, 1.031)	1.006 (0.983, 1.030)	1.007 (0.983, 1.032)
Number of older siblings	0.918 (0.828, 1.018)	0.962 (0.855, 1.081)	0.957 (0.850, 1.077)
Parental absence (Ref = parents presence)			
Either parent absence before 7		1.341*(1.047, 1.718)	1.203 (0.918, 1.577)
Either parent absence since 7			1.051 (0.777, 1.421)
Duration of breastfeeding before 7		1.013 (0.996, 1.030)	1.015 (0.998, 1.032)
Parent-child relationship		1.006 (0.987, 1.024)	1.008 (0.989, 1.026)
Maternal psychological distress before 7		1.077***(1.043, 1.112)	1.033 (0.986, 1.084)
House moves before 7 (Ref = no)		1.105 (0.905, 1.349)	1.090 (0.891, 1.333)
Family socioeconomic position before 7		1.099 (1.035, 1.166)	1.055 (0.906, 1.229)
Maternal psychological distress since 7			1.056* (1.010, 1.104)
House moves since 7 (Ref = no)			1.227 (0.984, 1.531)
Family socioeconomic position since 7			1.064 (0.907, 1.249)
Pubertal body mass index			1.041** (1.017, 1.065)

Note. We applied *Brant* test to test the proportional odds assumption. If the proportional odds assumption is not violated, we reported one odds ratio in the column OR; if it is violated, we applied the *generalised ordered logit model* (*gologit2*) and reported two odds ratios in the columns OR^a and OR^b.

[a]Heterosexual girls versus bisexual and homosexual girls.

[b]Heterosexual and bisexual girls versus homosexual girls.

*$p < .05$. **$p < .01$. ***$p < .001$.

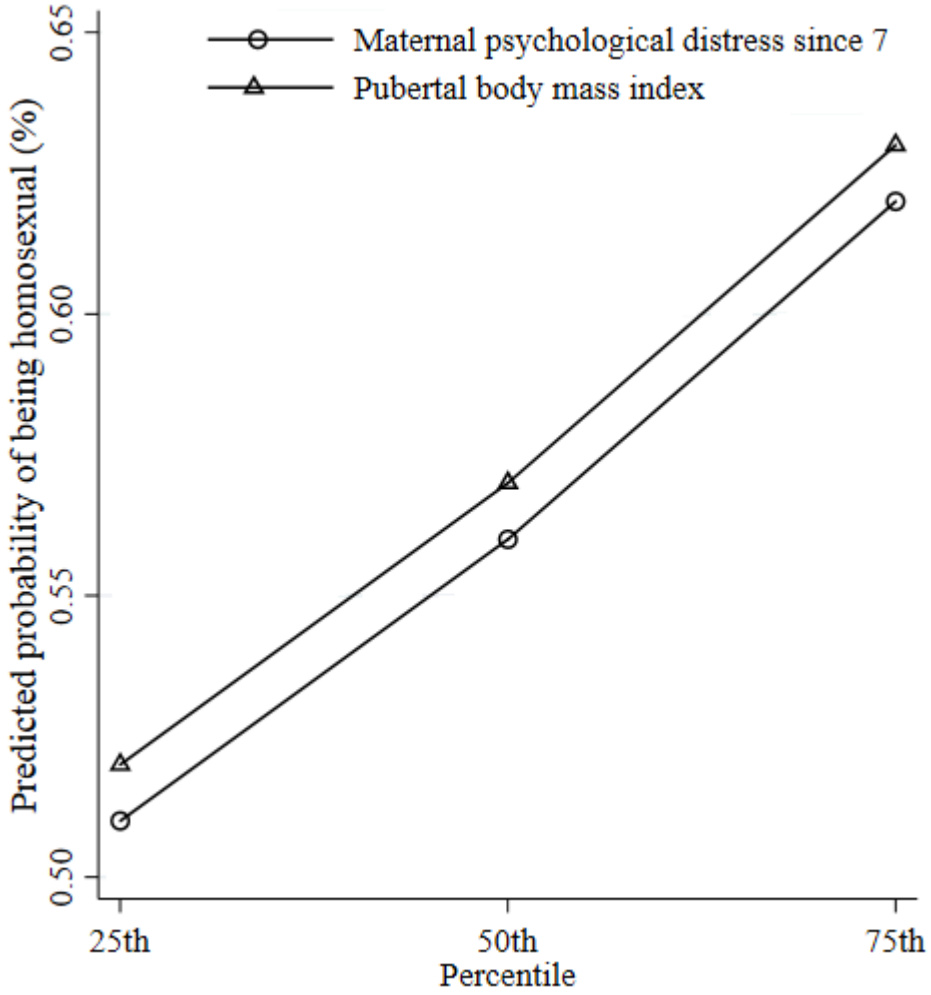

FIGURE1 Predicted probability of being homosexual for significant continuous early life conditions and psychosocial factors in the final model among girls.